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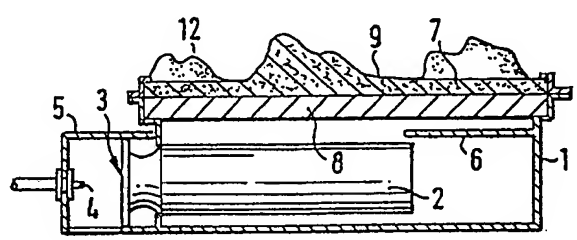
(54) **Gas burner.**

(57) A burner element for use in a self aerating gas fire, characterised by having in combination an apertured or self-porous, solid or bonded fibre distribution plate for passage of gas/air mixture without striking back of flame and, adjacent to the distribution plate, a plaque of open-pore ceramic foam for surface combustion of said mixture.



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GAS BURNER

The invention relates to gas burners, particularly burners for solid-fuel effect gas fires.

Many proposals have been made for solid-fuel effect gas fires to achieve good results both aesthetically and functionally. Some have worked well, yet improvements are still sought.

We have now found that an exceptionally satisfactory burner element for a self aerating fire is given by the use in combination of a self porous or apertured gas/air mixture distribution plate, which may for example be of solid ceramic or even metal but is preferably of bonded ceramic fibre, and disposed adjacently and preferably in contact with the distribution plate a surface combustion plaque of open-pore ceramic foam.

Solid ceramics and bonded ceramic fibre for the distribution plate used according to the invention are both well established materials in the art, solid ceramics in particular having been used since the earliest days of gas fires. Bonded ceramic fibre has also long been used and is discussed for example in our U.K. Patent specification No. 1 436 842. It is characterised by an open structure of refractory fibre that consists essentially of fibres, bonded where they cross and having free spaces between them, rather

than of a fired mass of ceramic containing embedded fibres. The porosity (void) volume of the structure is normally 60 or 65% upwards and can be 75 to 85%, exclusive of gas passages, and the continuous service temperature of fibre and bonding agent is normally at least 1000°C. Materials of both these kinds are conveniently used with gas/air passages formed in them, but alternatively a porous matrix of ceramic fibre may be used, the porosity having the same effect as open passages.

Ceramic foam materials suited for the surface combustion plaque used according to the invention are also known in themselves and their production is discussed for example in published PCT specification No. WO 84/01992 (application GB83/00282), though the plaque used for the purposes of the present invention need not be of the particular porosity and thickness specified there.

The materials are of porous ceramic, through the pores of which a combustible mixture of gas and air can be passed to emerge and burn at a surface of the element. It is made by impregnating a precursor matrix of a reticulated polyurethane foam, or like combustible foam material, with a ceramic slip or slurry, drying, and firing the impregnated material so as to burn out the combustible matrix and leave a porous ceramic structure corresponding to a lining or coating

of the cellular structure of the original polyurethane or other foam matrix. By selection of the precursor foam matrix and ceramic impregnant, the porosity of the ceramic foam can be determined and graded in terms of the number of pores per linear unit, for example pores per linear 25mm or per linear inch.

The distribution plate is conveniently of a structure comparable to ceramic fibre based burner elements on the market, particularly in respect of the size and distribution of the gas/air passages, designed on criteria well known per se to prevent the flame striking back but to offer only the minimum resistance to passage of the gas/air mixture and thus give a low pressure drop. A uniform or non-uniform distribution of gas/air passages may be provided, that is to say showing even distribution of gas or alternatively an increase at one location and decrease at another. The plate is preferably of low thermal conductivity so that heat is not radiated backwards from it, a property particularly shown by the bonded ceramic fibre referred to earlier.

The porous plaque gives an excellent appearance but is free of the limitations set on use and nature of the porous ceramic foam material when it is not only giving the surface at which combustion takes place but also controlling the gas/air flow and preventing striking back. It can be of uniform thickness or have thick and

thin areas as required, and the surface can be shaped and if required glazed or coloured to simulate coal, coke, or wood fuel. As stated above the porous plaque is desirably in contact with the distribution plate and while the construction of course retains it in place in service it need not be sealed either to the plate or to its mounting, and difficulties of sealing into a burner box are avoided. Moreover potential fragility of the foam plaque in manufacture or use is not an important problem, so that the close specifications otherwise required are unnecessary. The foam plaque is controlled as a burner by the distribution plate below, particularly in respect of even combustion.

A particular application of the burner element of the invention is shown by way of example in the drawings in which:

Fig. 1 is a plan of a base with the radiant burner element omitted; and

Fig. 2 is a longitudinal axial section of a complete gas burner assembly.

The gas burner assembly illustrated by Figs. 1 and 2 has a base comprising a metal tray box 1, forming a mixing chamber, having inserted through one end an air inlet tube 2 with a venturi mouth 3 into which is directed a per se known gas injector jet 4 carried by an open-bottom, air-inlet bracket 5 on the end of the box 1. In Fig. 1 the top of the bracket 5 is broken

away to show the jet 4 and venturi mouth 3. The tube 2 extends more than half way along the box 1 and opens beneath a shield 6 which baffles direct upward flow of gas/air mixture induced through the tube 2 by the gas jet entraining atmospheric air through the open bottom of the bracket 5.

The radiant burner element surmounting the mixture chamber includes a plaque 7 of ceramic foam material as below, formed into fuel-effect, coloured, impervious shapes 12. Closely below the plaque 7 there is provided a flat plate of bonded ceramic fibre 8 also as below.

The arrangement of the box 1 and tube 2 opening below the shield 6 ensures circulation of the gas/air mixture in the mixing chamber before it can pass through the plate 8 and plaque 7 to emerge and burn at the radiant surface 9. The dimensions and proportions of the assembly components are designed to suit the requirements of the fire as a whole and the porosity and thickness of the material of the plaque 7 and plate 8 and the size of the gas jet 4 are selected to suit a given gas and supply pressure, from mains or bottle.

The selection of gas injectorjet sizes is carried out according to criteria, such as of gas consumption and heat output, well known in the art. The size selected will also depend upon the gas supply pressure

and the type of gas used, examples of which are butane, propane, natural gas and town gas, i.e. gas manufactured from coal or other fuel, and ranges of sizes related to gas type and pressure are for example shown in the PCT specification GB83/00282 referred to herein, to which reference may be made, particularly at pages 6 and 7. As already stated however, there is no restriction to the ranges there given, which are essential to the particular purpose there disclosed but not to the present invention.

To provide the element with the simulated fuel appearance, part of the element face is sealed with a refractory glaze coloured or uncoloured for "unburnt fuel" and "ash" areas, and shaped to resemble solid fuel. Clearly, for any given element, this reduces the available pore passage for gas/air mixture to burn at the element face and the design and adjustment of the burner assembly is suited to it.

DISTRIBUTION PLATE

The ceramic fibre used for the distribution plate was "TRITON" (Trade Mark) fibre, an alumino-silicate material made from fused china clay and having the following published properties:

Melting point	1760°C
Continuous Service Temperature	1260°C max.
Fibre Diameter, average	2.8 microns

Analysis:

Alumina, Al_2O_3	45.1%
Silica, SiO_2	51.9
Iron oxide, Fe_2O_3	1.3
Titania, TiO_2	1.7
Magnesia, MgO	Trace
Calcium oxide, CaO	0.1
Alkalies as Na_2O	0.2
Boric anhydride B_2O_3	0.08
Nominal average fibre length	10cm

The distribution plate was made by vacuum casting from a slurry comprising 5 parts by weight of "Triton" fibre, previously chopped to a fibre length of about 0.3cm in "Manestry Rotogran Mk. III" sieve type granulator or similar machine, 2 parts by weight of China clay and 0.1 part by weight of boron phosphate mixed with 80 parts of water in a blunger. No dispersant was used other than a small amount of starch, about 0.1% of the solids content of the slurry.

This produced a soft, pliable green shape, which was dried in hot air and then fired to reach about 1050°C for not less than half an hour, giving a material strong enough to resist handling in normal commercial circumstances, though still friable if gouged with a steel tool or similar implement.

The clay, in the amount used, was found not to

affect the volume of the cast as compared to a cast made from the fibre alone, and acted only as a filler in the fibre structure. Considerable variations in binder content are possible, the limits being readily found for a given clay or other binder, for example colloidal silica, between insufficient cohesion in the fired plate on the one hand, and unduly slow casting and low porosity on the other. The preferred content of clay binder is about 2 parts by weight to 5 of fibre. The volume of this amount of clay is of course far less than the volume of the fibre.

The thermal conductivity of the cast and fired material was 0.3 B.Th.U. per inch thickness per square foot per hour per °F temperature difference, which at 1 B.Th.U./h = 0.293W (J/s) is 4.32W per cm. thickness per square metre per hour per °C temperature difference, at a temperature of the material of 600°F (316°C). The linear coefficient of expansion per °C was 4 x 10^{-6} and the density 0.5g/cc. The continuous service temperature of such material is over 1000°C (i.e. the temperature withstood continuously by fibre and bonding agent without loss of structure or softening.)

The cast block was of such thickness as could be conveniently machined to a thickness between about 0.8cm and 2.0cm, but preferably about 1.1cm, after drying but before firing, the length and breadth being determined by the specific application.

The casting tool consisted of a plate made from sintered bronze powder, 22 - 36#, pierced with a regular array of casting holes, these being covered by a fine wire gauze, to nominal BS standard 72 mesh. Passing perpendicularly through the sintered plate, through a series of further holes, was a protuberant array of stainless steel pins. These were affixed to a second, plain plate in such fashion as to enable them to be withdrawn through the sintered plate when casting was complete, so facilitating demoulding of the cast block.

The purpose of these pins was to allow an array of holes, which passed perpendicularly clear through the cast block, to be produced as part of the casting process and so obviate the need for any subsequent drilling.

The diameter and arrangement of the pins can be any such as accords with the well known principles of gas combustion and which gives the desired pattern of heating (or "picture") on the surface of the final assembly.

FOAM PLAQUE

The polyurethane or like precursor matrix foams, by the use of which the ceramic foam materials are made, are supplied by the foam manufacturers with a nominal

porosity stated in pores per linear unit. In practice, it has been found that there is a variable tolerance factor which may be as much as $\pm$ 5 pores per linear 25mm. This is due to the inexact nature of the precursor foam which is, of course, carried through to the resulting ceramic foam material. It must therefore be understood that the porosity values given in this specification are nominal values subject to manufacturing tolerances.

The porosity of the ceramic foam material used in the gas burners of the present invention is an important feature for satisfactory performance though as already noted not critical, as they are when the plaque is used alone as a burner. When ceramic foam materials of a porosity of 10 pores per linear 25mm are used, it may be difficult to get the required combination of stable combustion with acceptable radiant output because it has been found that the burner lights back, that is to say the flame front travels back from the outer face of the burner element to the inner surface towards the burner base. When ceramic foam materials of a porosity of 45 pores per linear 25mm are used, the pore size may be too small to pass a sufficient quantity of gas/air mixture to provide stable combustion and may thus show excessive back pressure in the mixing chamber, preventing sufficient air from being induced to provide the correct proportion for stable combustion. The preferred range is 15 to 40 pores per linear 25mm and

the best results have been obtained with a porosity of about 30 pores per linear 25mm.

The thickness of the ceramic foam material is not critical insofar that radiant output does not vary to any great extent as a function of thickness of the material for a given porosity. However, it has been found with a foam thickness of less than 8mm there is a tendency to light back. This is believed to be due to the relatively high thermal conductivity of the ceramic material compared to bonded ceramic fibre and therefore high heat transfer back. At the thicker end of the range there is no benefit in using a burner element thickness greater than 30mm, as back pressure increases and this can lead to unstable combustion conditions.

The type of ceramic foam material used and its density has not been found to be a critical factor in the performance of the gas burners of the present invention. The ceramic foam material selected should have adequate mechanical and thermal properties to withstand mechanical handling during assembly of the burner and repeated cycling to operating temperature. Cordierite ceramics have been found to be particularly suitable. Similarly, the bulk density of the ceramic foam material is not critical. Materials of low density tend to have less than adequate mechanical strength and those of too high a density tend to have a significant proportion of their porosity "blinded"

by continuous webs of the ceramic material. Cordierite foam materials of bulk densities in the range 0.13 to 0.25 g/cm^3 have been found to work satisfactorily.

EXAMPLE

A burner box of type similar to that shown in Figs. 1 and 2 and of interior length and breadth suitable for fitting a bonded ceramic fibre distribution plate of length 18cm and breadth 13cm was used.

This plate, manufactured as above, was pierced clear through with perpendicular holes, 0.16cm diameter, set in a square array at 0.64cm centres longitudinally and laterally across the face of the plate, leaving an un-pierced land of 1.5cm all around. The plate was fitted securely into the burner box in a gas-tight seating, being held in place with a metal bezel, which itself was firmly fixed to the burner box. On the plate was clipped a foam plaque as above, of similar linear dimensions and 0.1cm thick, and rated at a nominal 30 pores to the linear inch (2.54cm).

The burner box was fed with natural gas, at about 7½ to 8 ins. w.g. (about 20cm, water gauge) through a jet of orifice diameter 0.155cm, and gave excellent heat output and stability.

Advantages obtainable by use of the burner elements of the invention are:-

- The amount of gas burnt at each part of the element is largely independent of the permeability of the ceramic foam when the gas permeability per unit area of the foam is greater than that of the plate, as is readily arranged. Thus the burning at the surface of the foam plaque gives a good, even "picture", the distribution plate operating to control the foam plaque as a burner.

- Very open pore, thin ceramic foam may be used without any danger of striking back.

- It is not necessary to seal the edges of the foam into a burner mixing chamber for use.

- Conversion of gas to radiant energy as good as or higher than that of known on-ceramic or on-metal burner plates under atmospheric aspiration can be achieved.

- Average plaque surface temperatures as good as or higher than those obtainable with other atmospherically inspirated burners can be achieved.

- Burner flame stability in cross draughts is considerably increased as the flame front is slightly inside the foam surface.

- The frequency spectrum of energy emission can be extended at the high frequency end, without having to artifically aspirate the gas/air mixing system.
- Damage to the foam plaque surface, or cracking of the foam plaque does not stop burner operation or result in a dangerous condition.
- Due to the very light foam sections which are usable, the heating and cooling time is considerably reduced compared with prior burners.

CLAIMS

1. A burner element for use in a self aerating gas fire, characterised by having in combination an apertured or self-porous solid or bonded fibre distribution plate for passage of gas/air mixture without striking back of flame and, adjacent to the distribution plate, a plaque of open-pore ceramic foam for surface combustion of said mixture.

2. A burner element according to claim 1, wherein the surface combustion plaque is in contact with and supported by the distribution plate.

3. A burner element according to claim 1 or 2, wherein the gas permeability per unit area of the foam is greater than that of the distribution plate.

4. A burner element according to claim 1, 2 or 3, wherein the surface combustion plaque is shaped and optionally coloured or glazed to resemble solid fuel.

5. The burner element of claim 1, 2, 3 or 4 when mounted for service with the distribution plate facing the interior of a mixing and distribution

box for the gas/air mixture, the box being provided with a gas jet and an inlet for inspiration of air.

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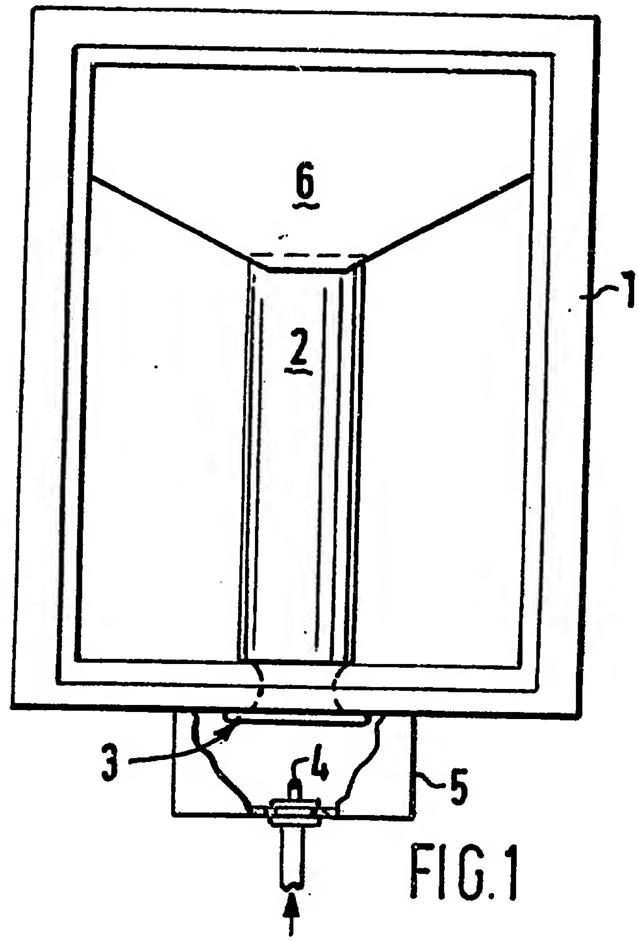

FIG.1

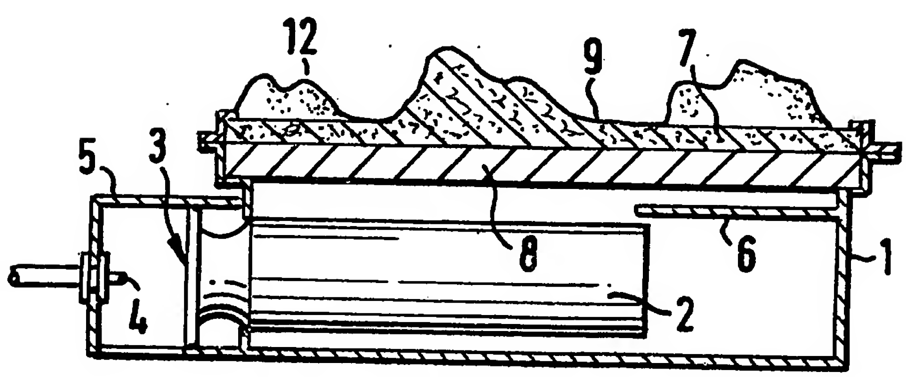

FIG.2